Sudbury Neutrino Observatory - Contamination Control

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Contamination control at SNO has several elements.[1] Before beginning the assembly of the detector it was necessary to establish a clean environment (air and surfaces) in the underground laboratory. These clean conditions were then be maintained throughout construction. In effect, the entire laboratory has become a clean room. The fresh air entering the laboratory and the air that is cooled and circulated within much of the laboratory passes through HEPA filters. Detector components are cleaned above ground and appropriately packaged for shipment underground. Material and equipment enters the laboratory through an interlocked area with high-pressure cleaning equipment. Personnel take wet showers and put on clean garments before entering the laboratory proper.

To control surface contamination one must be able to measure it and to monitor the factors affecting it. Commercial air-particle counters are used to sample the number and sizes of fine particles in the air. Several methods are used to measure the amount of contamination on a surface. X-ray fluorescence spectrometry (XRF) is used for more sensitive and precise measurements.

After more than 1000 days of operation since clean conditions were first established, fairly regular patterns and deposition rates have emerged. The quality of the air is characterized by an average class value of 2500 +/- 500. Average deposition rates range from 1 microgram/cm^2/month of mine dust in areas of high activity to one tenth that amount in areas of low activity. (The air particle counts and mass deposition rates are roughly consistent with the number-size distributions for airborne particulate measured inside the laboratory.) The level of cleanliness on the surface of the acrylic vessel is typically better than 0.1 microgram/cm^2, which is below the target limit. Zinc is also regularly observed in the XRF spectra at a level typically 20 % of the mine dust. The zinc comes mainly from the use of galvanized scaffolding in construction. Since a mass deposition of 1 microgram/cm^2/month integrated over a thirty month period would exceed the target contamination limits in any region of the detector, periodic cleaning of accessible surfaces and the use of dust covers on inaccessible areas is required.

In conclusion, maintaining a high level of cleanliness is essential to keep the radioactive background to a tolerable or low level. (Six grams of mine dust contains as much Th as thirty tons of acrylic - the mass of the vessel). While measurements (which sample only a minuscule fraction of the total detector area) suggest that we will be within our target limits after construction is completed, the success of the surface contamination control program (along with the programs for contamination control in materials and the water) will not be known until the detector has been filled with water and has undergone a "settling-down" period. In the meantime, it is interesting to note that one of the strongest impressions on visitors to the underground laboratory occurs when, at the end of a long walk in a hot, dusty and sometimes muddy mine tunnel 6800 feet under the ground, they make a transition to one of the world's largest clean rooms.

Footnotes and References

†Die Arbeit wurde mit Unterstuetzung eines Stipendiums im Rahmen des Gemeinsamen Hochschulsonderprogramms III von Bund und Laendern ueber den DAAD ermoeglicht.

1. NSD Annual Reports: 1991, p. 81; 1992, p. 87; 1994, p. 101; 1996, p. 127.